SUMMARY

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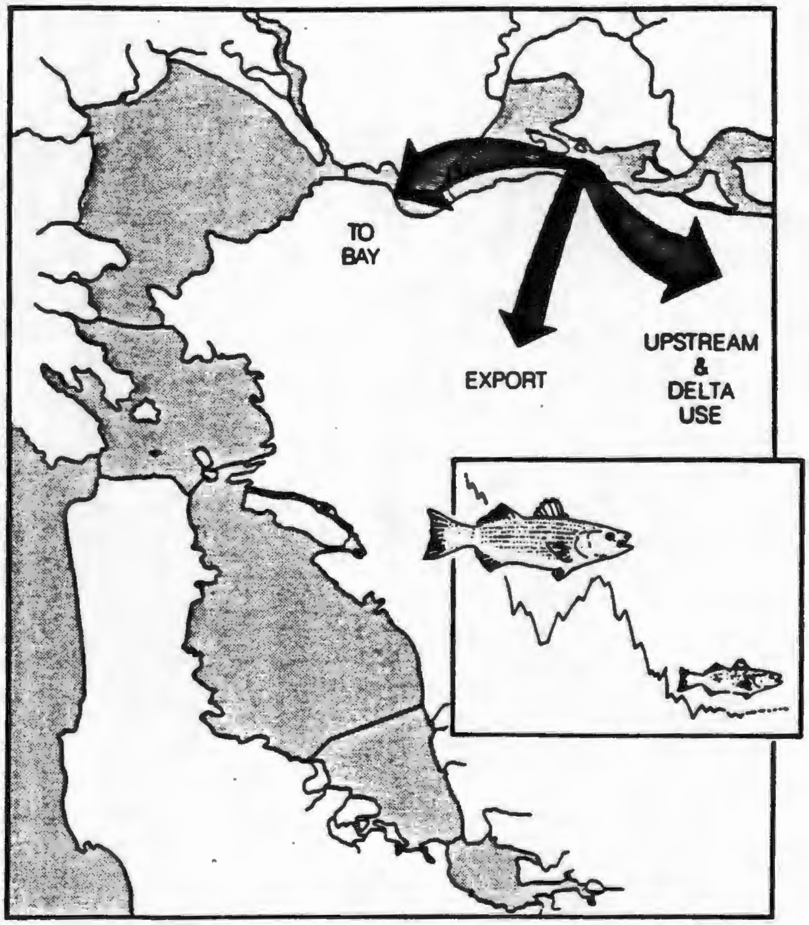

September 1987

Michael Rozengurt, Michael J. Herz & Sergio Feld

With preface by Joel Hedgpeth

Technical Report Number 87-8

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SUMMARY

THE ROLE OF WATER DIVERSIONS IN THE DECLINE OF FISHERIES OF THE DELTA-SAN FRANCISCO BAY AND OTHER ESTUARIES*

Michael Rozengurt, Michael J. Herz & Sergio Feld
(with Preface by Joel W. Hedgpeth)

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September 1987

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(Revision of Romberg Tiburon Center Exhibit #20 for the State Water Resources Control Board Bay-Delta Hearings)

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(This study follows our previous technical report, "Analysis of the Influence of Water Withdrawals on Runoff to the Delta-San Francisco Bay Ecosystem (1921-83)," as part of a series on the impact of water regulation on estuarine resources.)

SUMMARY, CONCLUSIONS & RECOMMENDATIONS

Estuaries, the meeting places of fresh and salt water, are among the world's most important natural habitats. Throughout history such areas have been critically significant because they provide fishing, transportation and recreation, as well as fresh water for drinking, power, irrigation, and waste disposal dilution.

Today, over half the people in the world live within 125 miles of a coast. Eighty percent of the global and 70-80% of the U.S. fish and shellfish catch come from areas influenced by fresh water and nutrient inflow from streams, rivers and estuaries. Many thousands of tons of salmon and other anadromous fishes caught each year migrated long distances from the ocean to their home rivers to spawn.

Published results regarding water development in rivers entering the Black Sea, the Sea of Azov, Caspian and Mediterranean Seas in Europe and Asia all point to the conclusion that when successive spring and annual water withdrawals exceeded 30% and more than 40-50% of the normal unimpaired flow respectively, (computed as the average for 50-60 years of observations), water quality and fishery resources in the river-delta-estuary-coastal zone (ocean) ecosystem deteriorated to levels which overrode the ability of the system to restore itself.

Commercial and recreational catches of Russian sturgeon, pike-perch, brim, mackerel, sprat, etc. have been extinguished in the Dniester and Dnieper Estuaries and the most productive Western part of the Black Sea since the late 1960's.

In the Sea of Azov (once the most productive sea in the World), the commercial catch of Russian sturgeon, as well as numerous other valuable semi-anadromous and anadromous fish, dropped from hundreds of thousands to several thousand tons over the last two decades of runoff regulation. (Their requirements for sufficient quantity and quality of water during migration and spawning are almost the same as for the Chinook salmon, striped bass and shad in the San Francisco Bay Area.) The same phenomena were observed in the Caspian Sea as well as with the commercial catch of Salmon in Northern Europe.

In the Nile Delta-Mediterranean Sea coastal zone, the coastal commercial catch of Sardinnela and other species that are dependent on runoff have dropped from more than one hundred thousand tons in the 1950's to several thousand tons since the Aswan Dam operation (1964).

The commercial catch of striped bass in the Chesapeake Bay region has declined up to 70% due to water regulation and pollution. The same percentage decline of fish and shellfish has been observed in the Delaware Bay and the Texas lagoons.

The impoundment of the Murray-Darling River system in Australia and construction of the salt barrier in its Delta has eliminated the fisheries in this area since the 1940's.

Comparable studies and many publications have reached similar conclusions; namely, despite reproductive cycles and behavioral and physiological differences among the estuarine fish species, historic catch levels for each appear to reflect underlying relationships which require specific volumes of runoff discharges, particularly in late winter and spring.

Under natural conditions approximately 60%-70% of the flow takes place during this period, and this flow is responsible for:

1) Repelling the intrusion of sea water into the Delta;

2) Providing necessary levels of nutrients (organic and inorganic materials, phosphate, silicates, nitrogen, etc.);

3) Producing flow conditions necessary for anadromous fish migration, spawning and rearing;

4) Creating a large entrapment zone which optimizes survival of fry and the food on which they feed;

5) Providing flushing and mixing flows to maintain water quality conditions (dissolved oxygen and temperature throughout the water column); and

6) Entraining large amounts of salty water as it flows through the estuary to the ocean, creating a dynamic salinity equilibrium within the system.

Although all of these conditions play important roles in the hatching and development of fish of a given year class, <u>it is extremely important to note that the state of the estuary during this period is heavily influenced by past runoff conditions as well</u>.

Despite the more than $2 billion spent over the past twenty-five years on the evaluation and management of <u>the Delta-San Francisco Bay ecosystem</u>, the basic understanding necessary to preserve its health has not been achieved. Without a clear picture of the complex factors that influence the Delta and Bay living resources and water quality, management decisions have been unable to reverse the decline of resources.

The research program of the Romberg Tiburon Center over the past three years was designed to (1) provide in-depth evaluation of freshwater inflow to the Delta and Bay, (2) assess the manner in which flow has been modified since the early part of this century (especially during the period following the completion of the major components of the Central Valley Project (CVP) and State Water Project (SWP)), and (3) assess the impacts of flow modification on the fishery resources of the system.

Purpose

The purpose of this report is to utilize the results of the previous investigation on the modification of freshwater flow to the Delta and Bay (Rozengurt et al., 1987a) to analyze the relationship between flow and commercial and recreational fish catches.

Methods

Our analysis was performed in two stages:

1) Annual commercial landings of salmon, striped bass and shad (mainly data for the pre-project period) were compared with spring and annual flows several years earlier. (The use of this procedure is based on the premise that flow has the greatest impact during the first seasons of an organism's life. This technique has been successfully used to show high correlations between flow during egg and larval stages and lobster catches as

long as 8-9 years later, as well as with shorter lag times for fish species generally landed 2-4 years after spawning.) Correlations between fish catch and the annual and seasonal flow conditions for a number of years preceding a given year's catch were calculated in order to examine cumulative effects of flow on fish from year of hatch to year of catch (3-5 years later).

2) The relationships between salmon fall run, Striped Bass Index of abundance and recreational catches (for the post-project period) vs. runoff were also examined with the same technique.

Findings

Modification of Freshwater Flow Conditions

As result of construction of the sophisticated CVP and SWP water storage facilities (with an accumulation capacity equal to 71% of normal unimpaired runoff) and conveyance systems into and out of the Delta (15-20% of the normal Delta outflow), the post-project period natural water supply to the Delta-San Francisco Bay estuarine system has been reduced to unprecedented levels:

1. Since 1967, absolute values of total diversions with predominant range of 10-12 MAF per year (with maximum values of 14-21 MAF) are 2.8 - 3.2 times (and up to 3-5 times) higher than before the CVP and SWP were completed (pre-project period 1915-1943). (Fig. 3-2)

2. The absolute values of predominant upstream diversion of 6-12 MAF for the post-project period, 1944-1984, are 3-5 times higher than for 1915-1943.

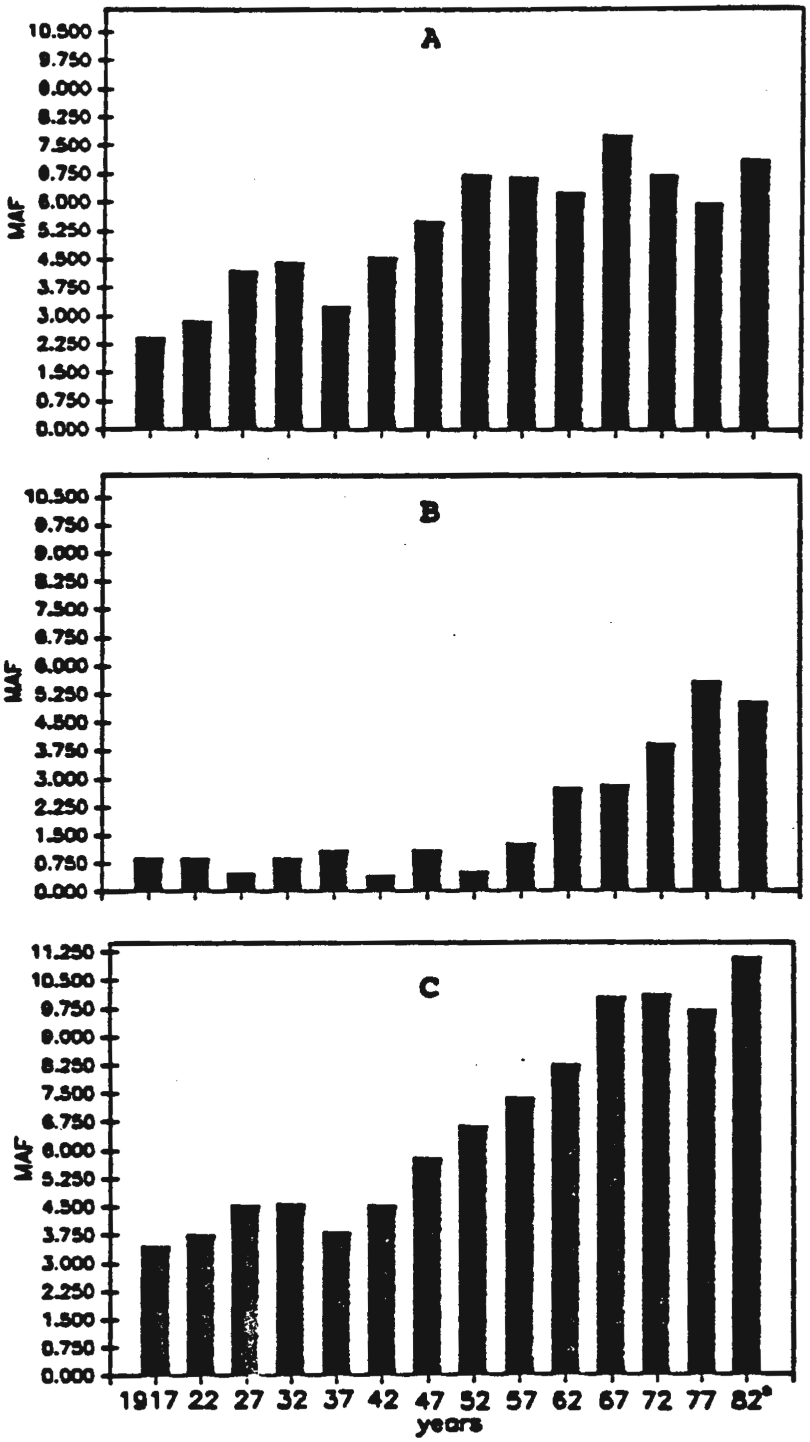


Fig. 3-2 The mean annual volume of water diverted for 5-year periods from the Sacramento-San Joaquin River basin during pre-project (1915-1943) and post-project (1943-1983) periods: A) Upstream, B) Inner Delta, C) Total Diversions. The years marked are the pivotal years of the period, e.g., 1917 = 1915-1919. (* = 4-year period)

Absolute values of downstream diversions (Delta consumptive use and export) were in some years, e.g., 1975, of the same magnitude as the upstream diversion, a phenomenon never observed in the pre-project period. The predominant range of annual Delta diversions since 1967 was 4-5 MAF. These values are almost 5 times higher than Delta water withdrawals before the projects were completed.

3. The major cause of these persistent decreases in annual runoff is that diversions in winter (primarily upstream) range between 15 and 45% and in spring (upstream and downstream) between 30 and 80% or more of the natural water supply of the Sacramento-San Joaquin River-Delta subsystem.

4. Since the projects' (CVP and SWP) operations began (especially from the late 60's on), winter and spring regulated water supply to the system was reduced 1.2-1.4 and 1.6-2.4 times in comparison with unimpaired mean winter and spring water supply to the Delta-Bay system, respectively, for 5-year periods (prevailing range of unimpaired runoff is equal to 3-4 MAF) (Fig. 3-10). Therefore, for the period 1967-1984, residual winter and, especially spring Delta outflow in the majority of cases corresponded to subnormal and below subnormal wetness when compared with statistics for unimpaired runoff.

5. Between 1944 and 1983, the upstream, downstream and total cumulative losses due to diversions reached 262, 104 and 366 MAF respectively. Cumulative upstream and downstream water losses amounted to 202 and 80 times, respectively, the volume of the Delta (1.3 MAF) while the total diversions account for 61 times the volume of the San Francisco Bay (6 MAF).

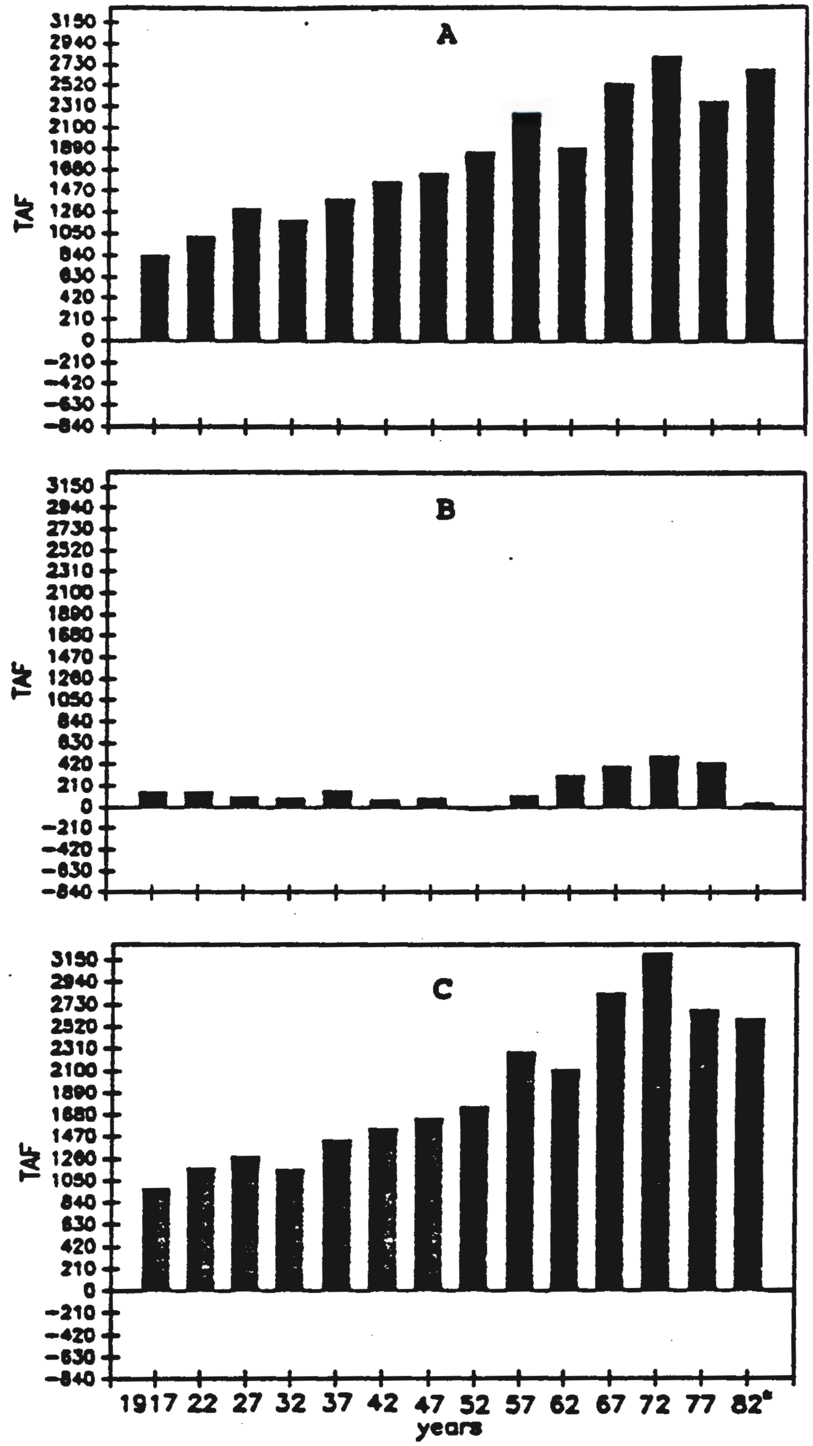


Fig. 3-10 The mean volume of water diverted for 5-year periods from the Sacramento-San Joaquin River basin during pre-project (1915-1943) and post-project (1943-1983) periods: A) Upstream, B) Inner Delta, C) Total Diversions, for the month of May. Negative diversions represent returning water from storage facilities and agricultural drainage network. The years marked are the pivotal years of the period, e.g., 1917 = 1915-1919. (* = 4-year period)

6. Analysis indicates that for the majority of 5-year periods, the mean regulated runoff is much less than normal, and has been replaced by volumes corresponding to subnormal and dry conditions. This water supply is <u>35-55% less than</u> the natural mean Delta outflow (27.2 MAF).

It should by emphasized that the above-mentioned losses in water supply sustained by the river-Delta-San Francisco Bay ecosystem infer concomitant losses, in millions of tons, of the organic and inorganic matter required to provide adequate ecological conditions for living resources. Moreover, the chronic freshwater deficit may result, as it was documented for the San Francisco Bay and many other estuaries throughout the world, in unfavorable changes in circulation patterns, mixing processes, salinity and other regime characteristics.

7. Based on the experiences of 1924 and 1976-77, it should be emphasized that under natural conditions, annual and spring residual runoff to San Francisco Bay of 3-5 MAF and <1.5 MAF, respectively, would occur only very rarely (once per 100 or more years). <u>If such extreme conditions occur on a regular basis, the Delta-Bay system will cease to function as an estuary and ultimately Delta agriculture, the fresh water quality (for drinking and irrigation), and the estuarine living resources will severely deteriorate.</u>

8. <u>Current decisions (including D-1485)</u> regarding water distribution in California are based on a water year-type classification system (the Four-River Index) which excludes 25% of the Sacramento-San Joaquin river watershed. As a result, the normal (long-term mean) Four-River Index runoff ($\bar{Q}$ = 17.2 MAF;

1921-1978) accounts for only 61% of the normal Sacramento-San Joaquin River inflow to the Delta originating from 100% of the basin area ($\bar{Q}$ = 28.2 MAF; 1921-1978). Therefore, evaluation of wetness of the year, residual runoff and consequent planning for water diversions, based on the Four-River Index, overestimate the level of water availability in a manner incompatible with the relatively meager natural levels of runoff. It follows that in normal, and especially in sub-normal and dry years , the Four-River Index classification system influences decision-makers towards permitting higher (and potentially damaging) levels of diversions.

Recommendations: Runoff

We strongly recommend (as in our previous report, Rozengurt, Herz & Feld, 1987a) that the SWRCB discontinue the use of the Four River Index classification system and substitute it with a system which utilizes flow from the entire watershed for the determination of natural seasonal and annual wetness type, and subsequently, volumes of water available for diversion and correspondance of residual flows to natural flow statistics (i.e., water year-type). Only if total outflow is used as the basis for classification will it be possible to provide the flows needed to protect and maintain the fish and other resources of the Delta-San Francisco Bay system (Fig.3-1).

In our opinion, the recommendations contained in Decision 1485 (based on the Four River Index system) have resulted in spring flow levels that are unprecedented in the recorded history of the system (frequency of occurrence less than once per 100 years). The excessive spring water withdrawals, compounded by the late winter water diversions, have significantly reduced annual river and Delta discharges and contributed greatly to the deterioration of the resources of the system during the past decade.

Modification of landings

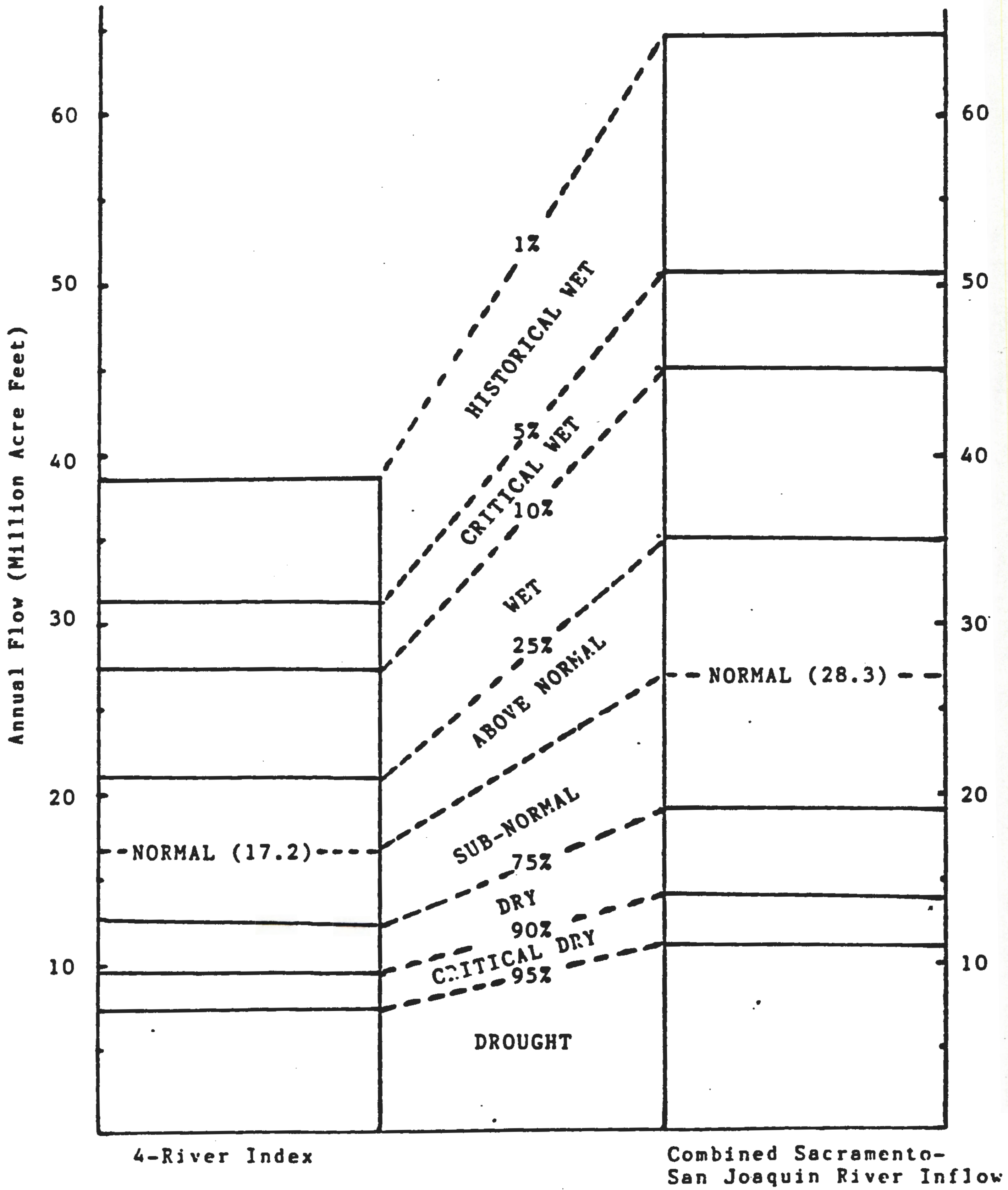
Chinook salmon (Oncorhynchus tshawytscha)

Between 1874 and 1914, commercial salmon catches in the Bay and Delta ranged from 2-11 million pounds per year (average = 6), and from 0.3 - 6 million pounds (average = 2) from 1915-1957 (when commercial fishing became restricted to the ocean). Since this span of time encompasses the pre-project and the beginning of post-project periods in water development, it affords an opportunity to assess the relationship between flow and salmon landings by examining catch/flow correlations.

1. For the 1916-1931 period, commercial salmon catch was highly correlated with annual mean regulated Delta outflow for the 5 years preceding (RDO_5) the year of catch ($r= 0.86$; $p<0.01$), indicating that the volume of annual flow (19-23 MAF) during the years between spawn and maturity influenced catch success. Similar results, but with a slightly lower correlation, were obtained for the 1944-1957 period.

2. Correlations between spring flows and salmon catch, especially during the 1916-1930 period, indicated that even stronger relationships existed between mean regulated spring (April+May+June/3) flows and commercial landings lagged by 3-5

Fig. 3-1
Comparison of Combined Sacramento-San Joaquin River Inflow and 4-River Index Water Year-Type Classification Systems. (% = probability of occurence)



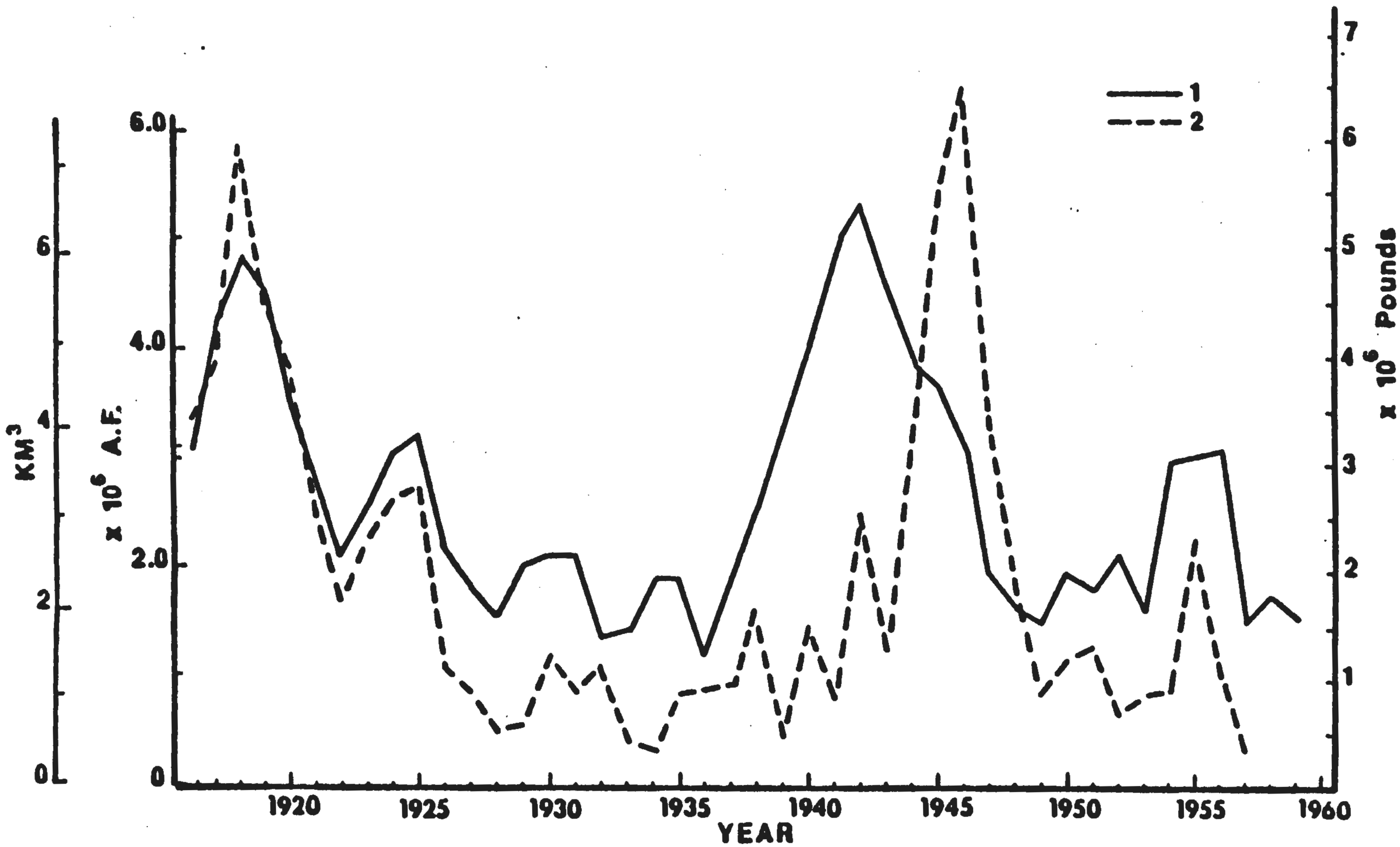


Fig 5-9 Relationship between (1) regulated Delta outflow for three moving months (April-May-June) and (2) commercial salmon catch in the Sacramento and San Joaquin Rivers. The salmon catch is based on a lag outflow period of 2 years; e.g., salmon catch for 1916 is based on outflow for 1912-14.

years of the spring runoff (r's = 0.80-0.97; $p < 0.05$). Successful catches resulted when spring flows averaged 2.5-4 MAF (or 42,014-67,222 cfs or 1,189-1,903 m^3/sec). (Fig. 5-9)

3. The number of fall-run salmon returning to spawn at Red Bluff (Sacramento River) also demonstrated reasonable correlation with annual and spring runoff for the years preceding the migration of a given year class and subsequent influence of high volumes of runoff on spawning success and survival.

Successful migration appears to require spring flows of 2.3-2.8 MAF (or 38,653-47,056 cfs or 1,094-1,332 m^3/sec).

In this case the total regulated spring Delta outflows of 6.9-8.4 MAF correspond to 40.6% and 44.2% of mean RDO of 17-19 MAF for several preceding years, respectively. (Here, as further in our discussion, the above-mentioned spring and annual volumes of RDO represent the statistics for years of subnormal wetness, e.g., 75-80% of probability of exceedence or recurrence interval of 4-5 years under conditions of unimpaired runoff.)

Striped bass (Loccus saxatilis)

1. Between 1889 and 1935 (when commercial fishing was banned), striped bass catches ranged from 0.5 and 1.4 million pounds. Populations have declined since that time and the recreational catch, which totaled approximately 60,000 fish per year in the early 1960s, dropped to 1,400 fish in 1980. The total Striped Bass Index of abundance has declined from a maximum of 117 in 1965 to a low of 6.5 in 1985.

2. Correlations between commercial striped bass catch and mean annual regulated flow for the 5 preceding years indicated a

good association for the periods 1918-1929 and 1916-1935 (r's= 0.70 and 0.79; $p<0.01$) while for spring, mean flow for 3 years (5 years before catch) showed slightly lower correlations (r's= 0.67 and 0.65; $p <0.01$) for the same periods.

3. These results indicate that optimal averaged commercial catches of striped bass (0.5 to 0.6 million pounds per year) were observed when average spring flows (April+May+June/3) for the preceding 3-5 years (lagged by 2-3 years) were in the range of 2.3-3.4 MAF. (38,653-57,139 cfs or 1,082-1,412 m^3/sec) and total spring RDO averaged between 6.9-10.2 MAF (or 38.3% and 46.4%, respectively, of mean annual regulated Delta outflow (RDO) of 18-22 MAF for 3-5 years prior to the year of catch) despite many regulations.

4. Correlations between recreational catch of striped bass and mean spring (April+May+June/3) and annual RDO for the preceding years (lagged by 3 years) illustrate that optimal recreational catch correspond to 2.0-3.0 MAF (i.e., total spring RDO of 6.0-9.0 MAF, or 35.3% and 42.9% of mean annual RDO of 17-21 MAF, respectively).

5. For the 1967-1981 period, correlations between the Striped Bass Index of abundance and 5-year running mean annual regulated Delta outflow yielded one of the highest correlations ($r = 0.97$; $p<0.05$), indicating that knowledge of the average flow conditions for 5 running years is a good predictor of Striped Bass Index level and therefore, abundance of fish suitable for recreational catch. These analyses indicate that five years of average annual regulated Delta outflow (RDO_5) of 15 MAF will be

followed by marginal bass abundance, while 18-21 MAF for 5 years will be followed by optimal bass populations.

6. Average spring (April+May+June/3) RDO_5 also were highly correlated with the Striped Bass Index for the 1959-1981 period ($r = 0.82$; $p<0.05$). As with annual flow, the results indicate that 3-5 years with average spring flows of 2-2.5 MAF (33,611-42,014 cfs or 951-1,189 m^3/sec) will result in optimal populations (total spring Delta outflows of 6.0-7.5 MAF correspond to 33.3-35.7% of mean annual Delta outflows for 3-5 years).

American Shad (*Alosa sapidissima*)

1. Between 1916 and 1957 (when commercial fishing was prohibited), landings ranged between 113,000 (1941) and 5.7 million pounds (1916). Correlations for the 1916-1931 period (when level of effort and techniques were relatively constant), indicate that average annual and spring regulated flows for the previous 3-4 years correlated quite well with the commercial shad catch ($r = 0.88$; $p<0.05$ for annual and $r = 0.89$, $p<0.05$ for spring flows).

2. During 1916-1931, landings of 1.5-2 million pounds followed 3- and 5-year periods with average spring Delta outflows of 2.5-3.5 MAF (42,014-58,819 cfs or 1,176-1,665 m^3/sec), i.e., for those periods total spring outflows of 7.5-10.5 MAF correspond to 41.7 and 42.0% of the mean annual flows of 18-25 MAF.

Conclusions

1. The similarities in the correlations between seasonal and annual regulated Delta outflow for the three species of anadromous fish suggest that a specific range of mean flows during consecutive springs, as well as consecutive years, have both a predictable effect on reproduction, recruitment in stock and catch success, and thereby supports the argument that there are cumulative effects of flow on fish (and perhaps on other species as well) in this and other estuaries.

2. In sum, for all three of the most valuable species of anadromous fish of the San Francisco Bay ecosystem (Chinook salmon, striped bass and American shad), the highest correlations between commercial catch and average spring and annual regulated outflows of the pre-project period of 1915-1943 (characterized by predominant upstream diversion) were obtained for catch of a given year against seasonal and annual regulated Delta outflow averaged for the preceding 3-5 years (RDO_3RDO_5).

3. As a rule, the mean spring RDO of 2.3-3.5 MAF (38,653-58,819 cfs or 1,082-1,665 m^3/sec), which correspond to 64-97% of the normal (unimpaired) spring Delta outflow of 3.6 MAF (for 1921-1978), provided the optimal commercial catch.

Under these conditions the prevailing range of annual averaged regulated Delta outflow was equal to 19-22 MAF (or 70-81% of the normal unimpaired Delta outflow = 27.2 MAF for the period of 1921-1978).

4. The highest correlations between production indices (salmon fall run and SBI), as well as striped bass recreational catch, and averaged spring and annual regulated Delta outflow for

several consecutive years of the post-project period of 1944-1985 may indicate that the range of 3- and 5-year running mean spring of 2.3-2.5 MAF (38,655-42,014 cfs) was able to maintain relatively tolerant ecological conditions for eggs, larvae and juvenile survival up to 1975. That is, total spring and annual RDO for the 3-5 years preceding the year of catch or index were 6.9-7.5 MAF and 17-19 MAF, respectively. (These ranges of spring and annual $RDO_{3,5}$ correspond to 64-70% and 62-70% of their normals, 3.6 and 27.2 MAF, respectively.)

When the gradual reduction of water supply exceeded these thresholds and reached mean spring and annual regulated volumes of 1.0-1.5 MAF and 11-15 MAF, respectively (or 27-40% and 40-55% of their normals), the signs of deterioration of environment of the riverine-estuarine system and its living resources became obvious.

It seems likely that the average spring water supply for several consecutive years contributes significantly to the adequate ecological conditions for eggs, larvae and juvenile survival. Therefore it is not surprising that these cumulative average regulated Delta outflows (with concomitant influence on nutrient level, salinity, temperature, dissolved oxygen, etc.) affect the overall estuarine environment and, as a result, the reproductive success of fish.

However, the predominant ranges of mean annual and spring water supply to the Bay for the 3- and 5-year periods were 1.5-2.5 times less (annual) and 2.5-3.5 times less (spring) than their normal levels for the last 10-15 years.

In our opinion, this, in combination with less visible man-induced factors, has resulted in a 19- and 60-fold reduction of SBI and salmon fall run between 1959-1985, respectively, as well as in the overall drastic decline of recreational catch of striped bass, recreational and commercial catch of salmon, shad, and steelhead trout in the Sacramento-San Joaquin river-Delta-Bay-coastal zone ecosystem.

The total economic losses due to declines in catch (between 1965-1986) of striped bass and salmon account for 1.6 billion dollars, or 2.6 billion dollars, if steelhead trout decline is taken into consideration (Meyer Resources, 1985; T. Beuttler, presentation at "Fish and Wildlife in the Bay-Delta Estuary" SWRCB Conference #4, 1986).

5. These and other similar historical examples of the relation between human needs for freshwater and protection of estuarine environments indicate that special consideration should be given to the consequences of timing and volume of spring and annual water withdrawals on recruitment and landings of anadromous fish because of their known sensitive response to cumulative fluctuations in freshwater supply. It may be possible to alleviate these problems and to protect water intakes in the Delta if limits to water diversion can be agreed upon, perhaps through the establishment of salinity and flow standards for San Francisco Bay (neither of which currently exist).

Recommendations

Based on this evaluation of modifications in regulated flows and their impacts on salmon, striped bass and shad populations and catches in the Delta and San Francisco Bay, we propose the following criteria for mean spring and annual regulated Delta outflows which must be maintained for periods of at least 2-3 consecutive years to ensure adequate water quality, seasonal displacement of the entrapment zone and optimal conditions for fish migration and spawning, as well as for juvenile survival and success in recreational and even commercial catch in the Delta-San Francisco Bay coastal zone ecosystem (Fig. 8-1, 8-2.; Table 8-1):

A. Total spring regulated Delta outflow = 6.9-7.5 MAF or mean spring (April+May+June/3) flows of at least 2.3-2.5 MAF (64.1-69.6% of the normal spring delta outflow, $\bar{Q}$ = 3.59 MAF) or 38.653-42.014 cfs.

B. Total annual regulated Delta outflows no less than 17-19 MAF (62.5-69.8% of the $\bar{Q}$ = 27.2 MAF).

Table 8-1 summarizes our recommendations for water standards and criteria to safeguard fisheries resources, based on our findings.

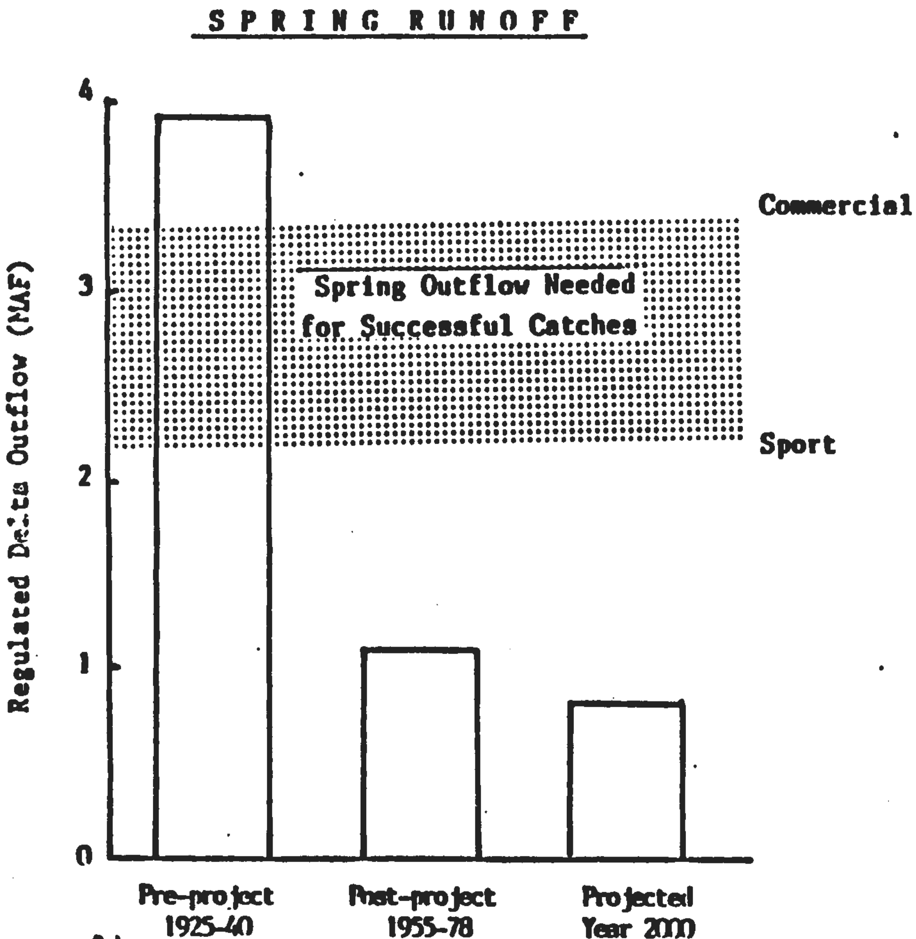


Figure 8-1
Pre-project (1925-40), post-project (1955-78) and projected (year 2000) spring regulated Delta outflow compared with outflow levels needed for successful commercial and sport fish catches (based on correlations between flow and catch for the 1915-40 period).

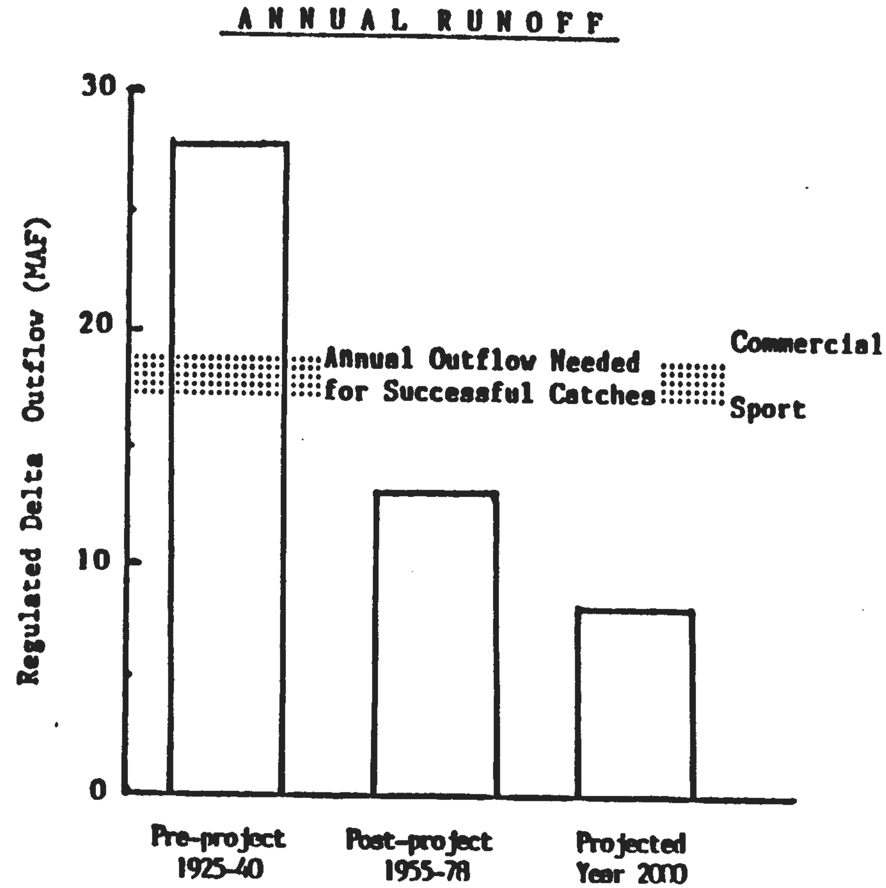


Figure 8-2
Pre-project (1925-40), post-project (1955-78) and projected (year 2000) annual regulated Delta outflow compared with outflow levels needed for successful commercial and sport fish catches (based on correlations between flow and catch for the 1915-40 period).

Table 8-1 Regulated Delta outflow and living resources of the river-Delta-San Francisco Bay ecosystem: pre- and post project observed values and recommendations*

Pre-Project Period - Observed Values:

Parameter\Fish	Commercial Catch		
	Salmon	Striped Bass	Shad
Total Spring Regulated Delta Outflow (RDO):			
MAF	7.5-12.0	6.9-10.2	7.5-10.5
(km^3)	(9.2-14.8)	(8.5-12.6)	(9.2-13.0)
Mean Spring RDO:			
MAF	2.5-4.0	2.3-3.4	2.5-3.5
cfs	42,014-67,222	38,653-57,139	42,014-58,819
(km^3)	(3.1-4.9)	(2.8-4.2)	(3.1-4.3)
(m^3/sec)	(1,189-1,904)	(1,094-1,618)	(1,189-1,666)
Annual RDO:			
MAF	19.0-23.0	18.0-22.0	18.0-25.0
(km^3)	(23.4-28.4)	(22.2-27.1)	(22.2-30.8)

-------------------- All 3 Species --------------------

	All 3 Species
Total Spring RDO:	
MAF	6.9-12.0
(km^3)	(8.5-14.8)
Mean Spring RDO:	
MAF	2.3-4.0
cfs	38,653-67,222
(km^3)	(2.8-4.9)
(m^3/sec)	(1,094-1,904)
Annual RDO:	
MAF	18.0-25.0
(km^3)	(22.2-30.8)

Table 8-1 continued

Post-Project Period - Observed Values:

Parameter\Fish	Salmon Fall Run	Striped Bass Index	Striped Bass Recreational Catch
Total Spring Regulated Delta Outflow (RDO):			
MAF	6.9-8.9	6.0-7.5	6.0-9.0
(km^3)	(8.5-11.0)	(7.4-9.2)	(7.4-11.1)
Mean Spring RDO:			
MAF	2.3-2.8	2.0-2.5	2.0-3.0
cfs	38,653-47,056	33,611-42,014	33,611-50,417
(km^3)	(2.8-3.4)	(2.5-3.1)	(2.5-3.7)
(m^3/sec)	(1,094-1,332)	(952-1,189)	(952-1,428)
Annual RDO:			
MAF	17.0-19.0	18.0-21.0	17.0-21.0
(km^3)	(21.0-23.4)	(22.2-25.9)	(21.0-25.9)

Recommendations for all 3 species:

	Recreational and Limited Commercial Catch
Total Spring RDO:	
MAF	6.9-7.5
(km^3)	(8.5-9.2)
Mean Spring RDO:	
MAF	2.3-2.5
cfs	38,653-42,014
(km^3)	(2.8-3.1)
(m^3/sec)	(1,094-1,189)
Annual RDO:	
MAF	17-21
(km^3)	(21.0-25.9)

----

* Note:

The recommended total spring RDO for several years prior to migration and spawning of anadromous fish accounts for 63.9-69.4% of the normal spring Delta outflow of 10.8 MAF. The recommended total annual RDO accounts for 62.5-69.8% of the normal annual Delta outflow of 27.2 MAF. In this case, total

Table 8-1 continued

winter RDO of 8.5-9.5 MAF will account for 61.5-68.7% of the normal winter Delta outflow of 13.8 MAF; the total summer-autumn RDO of 1.6-2.0 MAF will account for 62.0-77.5% of the normal summer-autumn Delta outflow of 2.6 MAF.

The monthly redistribution of regulated outflows may differ from the seasonal averages (especially for winter and spring) provided that their volumes are able to maintain optimal balanced water quality conditions for the different water users.

Because, in our investigation, fish landings and indices are indicators of the health of the environment, the 3- and 5-year running mean RDO are assumed to be responsible for providing optimal conditions for:

- Landward migration, spawning and rearing,
- Seeward migration of juvenile fish,
- Physical, chemical and biological parameters of the entrapment zone (including nutrient supply) as well as its ultimate - spatio-temporal dynamics within the Suisun Bay - Carquinez Strait area,
- Adjustment of juvenile to salinity fluctuations in transition zones of the Delta-Suisun Bay subsystem,
- Water quality in the Delta suitable for different water users,
- Flushing intensity necessary to maintain adequate water quality in the esuarine system.

The recommended optimal range of Delta outflow discharges do not preclude the possibility of additional man-regulated releases, provided these releases will not result in the destabilization of the Delta levees (which have adjusted to impaired runoff and sediment load over the last forty years) or in the development of "shock" conditions for eggs, larvae and juvenile fish.

CONVERSIONS:

Cubic feet per second (cfs) x .028317 = cubic meters per second (m^3/sec)

Acre feet x 1.233 x 10^{-6} = cubic kilometers (km^3)

In our view, any statement published in the past claiming that it is possible to restore a historical level of fish population should be considered erroneous.

The restoration of historical fish levels would only be possible if historical levels of unimpaired runoff discharges, by season and year, as well as historical migration routes of spawning fish and their habitats were also restored.

Moreover, based on worldwide experience, as well as on the development of commercial and recreational fisheries on the Delta-San Francisco Bay ecosystem, future success in fish landings will depend upon the amount of water discharged into the estuarine system especially in the late winter-spring, rather than on the production of hatcheries. Hatcheries may create the illusion of preventing the extinction of a species but cannot restore the historical level of natural fish populations.

Therefore, only economically and ecologically balanced water management can adequately guard the interests of the estuarine environment and its water users. We cannot restore but we can preserve.

COPY

SFSU

San Francisco State University
1600 Holloway Avenue
San Francisco, California 94132

School of Science
415/338-1571

September 27, 1988

Congresswoman Barbara Boxer
88 Belvedere Street #D
San Rafael, CA 94901

Dear Congresswoman Boxer:

In our attempt to keep you continuously informed about the progress on understanding the San Francisco Bay-Delta System, I enclose for your information a review of two technical reports of the Romberg Tiburon Center for Environmental Studies, received from Dr. Michael Champ of the National Science Foundation, as well as the cover page from the journal Estuaries of which Dr. Champ serves as editor. These reports, by Michael Rozengurt and Michael Herz, were presented as Romberg Tiburon Center Exhibits 1 and 20 at the recent Delta-Bay Hearings of the State Water Resources Control Board. Dr. Champ is a scientist of international reputation in this field and his very positive comment regarding the work by our scientists at the Romberg Tiburon Center is an important one.

These reports are the first of their kind in the evaluation of the role of man's historical activity on water supply and diversions in the Sacramento-San Joaquin-San Francisco Bay ecosystem watershed. In addition, the reports highlight the interrelation between fisheries and runoff in order to provide a reasonable recommendation on the rate of water diversions and discharges necessary to maintain fisheries and the entire environmental health of the ecosystem and its agricultural, municipal and industrial water intakes in the Delta.

This research embodied in the two technical reports was supported by grants from the San Francisco Foundation and the Marin Community Foundation.

I hope you will be able to take the time to read this review. If you have any further questions, please feel free to contact me at 415/338-1571.

Sincerely yours,

James C. Kelley

James C. Kelley
Dean, School of Science

JCK/rc

cc: Dr. Robert Corrigan, President, San Francisco State University
Dr. Douglas Patino, President, Marin Community Foundation
Dr. Robert Fisher, Director, San Francisco Foundation
State Water Resources Control Board
Dr. Michael Rozengurt, Tiburon Center for Environmental Studies
Dr. Michael Herz, Tiburon Center for Environmental Studies

10 August 1988

Dr. James C. Kelley, Dean
San Francisco State University
1600 Holloway Avenue
San Francisco, CA 94132

Dear Jim:

Thank you for the opportunity to review the following two Technical Reports of the Romberg Tiburon Center for Environmental Studies:

(1) "Analysis of the Influence of Water withdrawls on Runoff to the Delta-San Francisco Bay Ecosystem (1921-83)." May 1987, by M. Rozengurt, M.J. Herz, and S. Feld. Tiburon Center Technical Report No. 87-7.

(2) "The Role of Water Diversions in the Decline of Fisheries of the Delta - San Francisco Bay & Other Estuaries." September 1987, by M. Rozengurt, M.J. Herz, and S. Feld. Tiburon Center Technical Report No. 87-8.

The first of these two reports is perhaps one of the most significant technical studies written on the effects of water resources management activities on coastal ecosystems prepared in the last 20 years. I will not be surprised if it becomes a classic. The analysis is extremely comprehensive and complex. A few of us on the east coast have noted that every 5 years or so, someone or a small group in California manages to identify the next national environmental problem, such as this study on low flow. It must be something in the water. A second coincidence, which I consider to be very important here, is to have in California, a hydrologist who was a key player in the studies of the system level effects of large freshwater diversions in Russia. These studies and their results were unknown outside of Russia, until Dr. Rozengurt published his first paper in the U.S. (Rozengurt and Haydock, 1981).

The dissemination of the results of these Russian studies is very important to water resource management all over the world. During the Christmas Holidays of this past year, I served as a referee for a very comprehensive manuscript for CRC Press's Critical Reviews in Marine Science by Drs Rozengurt and Hedgpeth entitled: "The Impact of Altered River Flow on the Ecosystem of the Caspian Sea." The manuscript, which will be published in the December issue summarized the results of a large number of Russian studies of the lower Volga-Delta-North Caspian Sea and developed a conceptual model of the system effects of runoff reduction due to diversion on the estuarine environment and living resources.

I have prepared a separate review for each technical report.

I concur fully with the approaches utilized for data reduction and analysis, and the subsequent interpretations, and conclusions in Technical Report 87-7. Technical Report 87-8 is not as comprehensive nor as sophisticated because it is a correlation study which utilizes calculated flow data from 87-7 for correlation to fisheries catch data. The results and conclusions of Technical Reports 87-7 and 87-8 will stimulate many similar studies in estuaries all over the world. Both Technical Reports could use a general executive type summary up front to lay out the total scope and results of each study.

My review comments are attached, and if you have any questions, please do not hestitate to contact me.

Sincerely

Michael A. Champ
7000 Vagabond Dr.
Falls Church, VA 22042

(202) 357-9707

Encl.

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DEDICATED ISSUE
Long-Term Biological
Records

ESTUARIES

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JOURNAL OF THE
ESTUARINE RESEARCH FEDERATION

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, Maryland 20910

SEP 12 1989

Dr. Robert A. Corrigan
President
The California State University
400 Golden Shore
Long Beach, California 90802-4275

Dear Dr. Corrigan:

This is to notify you of our appreciation for the recent presentation on the effects of water diversions in California's Central Valley by Dr. Michael A. Rozengurt, Senior Research Scientist at the San Francisco State University's Tiburon Center for Environmental Studies. His excellent and timely presentation on July 18, 1989, made us aware of the threat of massive diversions of freshwater inflows away from highly productive, estuarine ecosystems, such as San Francisco Bay. The National Marine Fisheries Service, as steward of the nation's living marine resources, considers alteration of freshwater inflows to estuaries as one of the four highest priority threats to the continued survival and productivity of the nation's living marine resources. The "health" of estuarine ecosystems is, therefore, of major concern to us.

Staff members also attended Dr. Rozengurt's presentation to the U. S. Congress' Environmental and Energy Study Conference, in joint session with the U.S Global Strategy Council, on the world-wide effects of massive freshwater diversions away from estuarine systems. While the effects of diversions on valuable fisheries resources are severe, they pale in significance compared to adverse societal effects of desertification due to saltwater intrusion into adjacent groundwater, thus compromising human habitation of large deltaic areas. Moreover, Dr. Rozengurt's presentation at the recently concluded International Symposium on Wetlands and River Corridor Management, sponsored by the Association of State Wetland Managers, was considered by many in attendance, including our own scientists, to be the most dramatic and important of the entire symposium.

Dr. Rozengurt's professional and scientific contributions have led to our awakening recognition of this critical national and international issue. His work has been significant and the California State University is to be commended for its support for such scientific inquiry and synthesis as applied to difficult public policy decision making.

Sincerely,

/s/ James W. Brennan

James W. Brennan
Assistant Administrator
for Fisheries

cc: Dr. Michael A. Rozengurt

bcc: F(2), Fx1, Fx3, F/SWR, F/SWC, F/PR, F/CM, F/RE, F/PR4, F/SWC3, F/SWR13, F/SEC9, F/SEC6, F/SER, F/SER11, F/NER, F/NER74, F/NEC, CSOP, CSEP, CSCO

NMFS: F/PR4: JChambers: 427-2319: 8/9/89:retyped:gect:9/6/89

L. Eugene Cronin
Coastal Consultant
12 Mayo Avenue, Bay Ridge
Annapolis, MD 21403
301-267-6744

8 May 1988

James C. Kelley, Dean
San Francisco State University
1600 Holloway Avenue
San Francisco, CA 94132

Dear Dean Kelley:

I have reviewed the Report The Role of Water Diversions in the Decline of Fisheries of the Delta-San Francisco Bay and Other Estuaries with exceptional interest.

My response is in three parts:

a. Marginal and text annotations on the manuscript, which has been sent to Dr. Rozengurt.

b. The enclosed "Review comments" on general aspects of the report.

c. This letter, including response to the specific requests of your letter of 8 March 1988.

The most effective and important among a number of significant contributions in the Report appear to me to be:

1. The basis for analysis and managerial control of the flows from the Sacramento-San Joaquin-Delta system to the estuary has been seriously in error, leading to damaging potentials for the estuary. It should be corrected as recommended. Tha basis for that conclusion is well laid and convincing.

2. Massive reduction in the release of fresh water because of diversions, especially in spring, has contributed heavily to reduction in the production of valuable species of anadromous fish. The evidence is very impressive and I believe that the conclusion is correct. It is, obviously, unfortunate that there is a lack of the data required to link flows more closely to the production of salmon, striped bass and shad. We all wish that additional detailed observations had been made in the past - but they do not exist.

The approach employed by the authors is imaginative, carefully executed and about as good as I have seen among those who attempt to hindcast, or rather identify possible relationships in retrospect. There are always serious uncertainties in developing and evaluating co-incidences and even more in attempting to prove co-relations or causality. The authors are fully aware of these difficulties. The Report may receive criticism based on the inherent limitations or retrospective search for relationships, and some of the criticism may be valid. However, the strength of developing indications of the importance of time-lagged flows on the abundance implied by harvest is very impressive.

In my opinion, any significant critics should bear the burden of demonstrating equally well any more probable cause of the declines.

In fine, I consider that the Report reveals quite probably relationships between flow and stock production. I suspect that there may be additional negative effects of the massive diversions on other parts of the estuarine ecosystem, but these will require additionmal data and analysis.

If I were seeking a basis for rational management of diversions based on a committment to protect valuable estuarine resources, I would adopt the recommended flow patterns until, and unless, even more convincing evidence is provided and broadly accepted favoring a different management regime.

Thank you for the opportunity to participate in this review.

Cordially,

L. Eugene Cronin

cc: Dr. Rozengurt

ABAG
ASSOCIATION OF BAY AREA GOVERNMENTS
Mailing Address: ■ P.O. Box 2050 ■ Oakland, CA 94604-2050

Rottenquist

RECEIVED
DEC 13 1988
San Francisco State University
School of Science

November 30, 1988

James C. Kelley
Dean, School of Science
San Francisco State University
1600 Holloway Avenue
San Francisco, CA 94132

Dear Dean Kelley:

Revan Tranter was delighted to receive your letter enclosing a review of two technical reports on the effects of altered water flow on estuary systems.

Because I work closely with the San Francisco Estuary Project, housed in the ABAG offices, he asked me to forward comments.

After reviewing the material you sent, two issues come to mind. First, these technical reports develop new, badly needed, information on the effects of freshwater diversion on the Bay and Delta ecosystems. Second, the reports point out the critical need for collecting additional information--specifically long-term data sets.

One of the purposes of the San Francisco Estuary Project is to identify data gaps, then develop a plan to fill these gaps. The Project members know of these reports. In fact, Mike Herz is an alternate on the Project's Technical Advisory Committee.

The information contained in these reports will certainly be useful in identifying and prioritizing data gaps.

Revan asked me to forward your letter and the attached information to the Project's staff so they may call it to the attention of the soon-to-be appointed San Francisco Estuary Project Manager.

Many thanks for commending these reports to Revan and ABAG. He appreciates being kept abreast of state-of-the-art technical papers of direct value to projects in which ABAG is an active partner.

Sincerely yours,

Cathryn A. Hilliard

Cathryn A. Hilliard
Director of Public Affairs

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Fisheries Center
Tiburon Laboratory
3150 Paradise Drive
Tiburon, CA 94920

March 15, 1988 F/SWC3:JAW

James C. Kelly, Dean
School of Science
San Francisco State University
1600 Holloway Avenue
San Francisco, CA 94132

Dear Dean Kelly:

Recently I evaluated a report by Michael J. Rozengurt, Michael J. Herz and Sergio Feld entitled "The role of water diversions in the decline of fisheries of the Delta-San Francisco Bay and other estuaries." In February I forwarded six pages of comments to Dr. Michael Rozengurt and discussed the report with him. My primary intent was to be helpful wherever possible.

In my opinion, Dr. Rozengurt has made some extremely important points with regard to the determination of valid historical flow. I think he has raised some serious questions about how water quality decisions are made by the State of California. I agree with his redefinition of flow and his analysis. I believe the review of Dr. Luna Leopold also substantiates Dr. Rozengurt's analysis. In particular, I agree that the increased probability of subnormal wetness due to water diversion is probably a major factor contributing to fisheries declines in the San Francisco Bay-Delta area. The decreased wetness of the spring period is particularly important in affecting spawning and larval development of striped bass.

I recommended that Dr. Rozengurt have his work evaluated by a fisheries statistician, and I also recommended that he do further editing on the ms for purposes of clarification. On the whole, however, I feel he has made an important contribution to understanding environmental problems in the San Francisco Bay-Delta ecosystem.

If you would like a copy of the more specific editorial comments I sent to him, I would be happy to provide them.

Sincerely yours,

Jeannette A. Whipple

Jeannette A. Whipple
Acting Director, Tiburon Laboratory

✓BCC: M. Rozengurt (TCES)

Applied
Science
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December 23, 1987

Dr. Michael Rozengurt
Tiburon Center for Environmental Studies
San Francisco State University
P.O. Box 855
Tiburon, CA 94920

Dear Dr. Rozengurt:

Thank you for sending me copies of your two reports on the analysis of the influence of water withdrawals on funoff to the Delta-San Francisco Bay ecosystem. Let me first apologize for not responding to your letter of November 2, 1987 sooner. I was on travel for the entire month of November 1987 and am just now digging my way out of a pile of papers, reports, etc.

I have read your report with interest and see the striking simularities to problems David Tolmazine studied in the the Black Sea. You have clearly documented the problem with your analysis of freshwater inputs to the system and how they have been changed by diversions and withdrawals. What is conspicuous by its absence from reports is how the folks who manage freshwater in California got themselves in such a situation. It would have been most interesting to know how the water authorities assessed the impact of proposed withdrawals/diversions on the ecosystem. Did they do any analysis? Why was the analysis faulty. Surely the U. S. Army Corp of Engineers did their famous San Francisco Bay physical model or the USGS and their numerical model have addressed the impact of water withdrawal/ diversion on receiving water quality. Was their models wrong? Why?

Certainly it is not necessary for you to address there questions in your report. They, however, seem to be obvious questions that need to be investigated if one is to come up with a rationale way to trade off freshwater contracts against the bay exosystem health.

As an aside, I've enclosed some information on our company, ASA for your interest. We specialize in numerical modeling of coastal estuarine and shelf processes and apply our models to assess impacts associated with various developments as the environment.

I wish you success in your work. Please keep me on your mailing list.

Sincerely,

Malcolm L Spaulding

Malcolm Spaulding L.
note: Dr. Spaulding is a professor of
Oceanography at the University of Rhode Isla

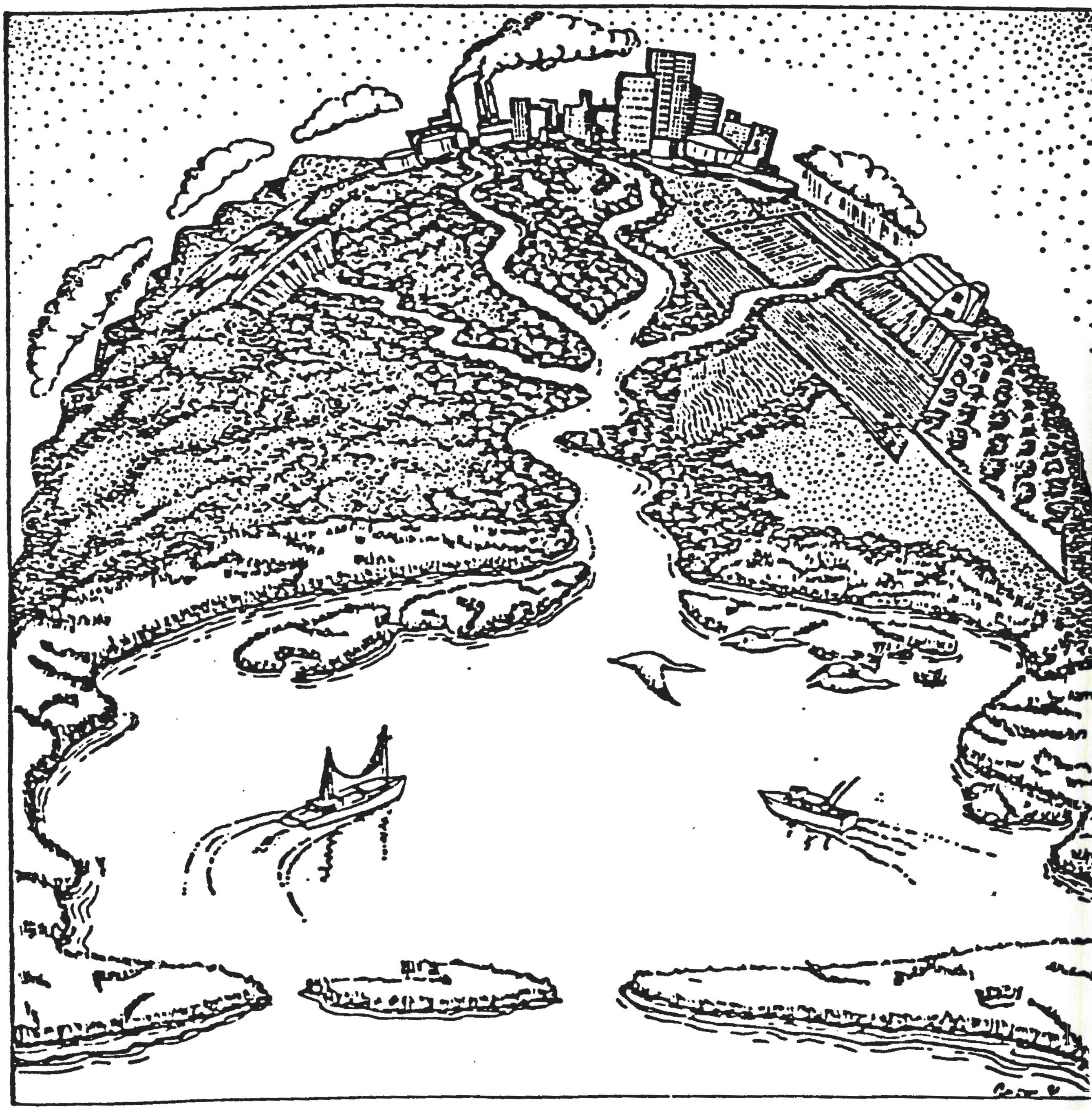
MS:ck

Biological Services Program

FWS/OBS-81/04
October 1981

Proceedings of the National Symposium on Freshwater Inflow to Estuaries

VOLUME II



Fish and Wildlife Service

U.S. Department of the Interior

SUMMARY AND RECOMMENDATIONS OF SYMPOSIUM

John Clark

Conservation Foundation, Washington, D. C.

Norman Benson

U. S. Fish and Wildlife Service, Slidell, Louisiana

INTRODUCTION

The goal of the National Symposium on Freshwater Inflow to Estuaries was to review the management, planning, and scientific and technical problems associated with freshwater inflow to estuaries and to formulate recommendations to include freshwater inflow in the planning and management processes. Thus, the Symposium was organized to develop and assemble information and to propose action programs.

The Symposium revealed that, although the importance of estuaries has been recognized by Congress and others, few actions have been taken to protect them. As a society we find ourselves talking about the importance of estuaries and how they should be saved while our actions, or lack of action is the result of many causes: the complex nature of estuaries, the geographical differences in their requirements and man's effect on them, our often fragmented single-discipline and single-purpose approach toward them, and our willingness to act without a clear understanding of the ultimate effects of our actions. It was recommended that there should be a renewed nationwide mandate to recognize estuaries as resources of extremely high value, and that nationwide conservation objectives should be established that can be visualized and applied by the public, engineers, scientists and managers. Optimal salinity regimes should be established as conservation objectives for each estuary, with optional sediment and hydrologic regimes as related objectives.

The Symposium's opening plenary session described the high values of estauries to the Nation for recreation, food and aesthetics. Freshwater inflow problems were identified in Raritan Bay, Chesapeake Bay, southern Florida, the Gulf of Mexico, San Francisco Bay and the Columbia River estuary. The problems identified include the reduction of volume of freshwater inflow, modification of seasonal flow regimes, reduction of water quality, and alteration of sediment and nutrient content in freshwater inflow. It was emphasized that estuarine degradation and management must be dealt with more effectively if estuaries are to continue to produce the products and services that the Nation expects of them. The need to determine the effects of various types of management on estuarine ecosystems was emphasized. It was also pointed out that many estuary production processes and environmental problems are not directly related to freshwater inflow, and that ecosystem planning and management must consider all man-related actions that affect estuaries. Several speakers noted that problems exist in defining the freshwater needs of estuaries, and that widely recognized criteria are needed for setting ecological goals in estuaries. Because of the lack of data, the freshwater needs of many estuaries cannot compete with the more clearly defined needs of agriculture, industry and cities.

This review summarizes some of the pertinent research findings that were presented, some of the planning problems identified, specific recommendations that were presented in papers or in discussion, and general recommendations on how the protection of estuaries may be pursued. General conclusions are offered.

RESEARCH FINDINGS

The relations between freshwater inflow and biological production and processing in estuaries were described in many papers. Several papers emphasized the need for long-term (6 to 15 years) data before we can develop an understanding of estuarine ecosystems. However, a combination of data files and sophisticated prediction methods can be used to aid decisionmaking where insufficient time series data exist. The importance of temperature of river inflow on estuarine organisms was recognized in Chesapeake Bay for striped bass and in Louisiana for shrimp and oysters. Natural temperatures of incoming rivers are being altered by the passage of river water through power plants and by water being discharged from reservoirs and other water-control structures on rivers. In some areas the positive correlation between shrimp production and freshwater inflow has been shown but remains unexplained. Benthic infauna production was directly related to freshwater inflow and may be one reason for the positive correlation between freshwater inflow and shrimp production.

Drainage ditches in North Carolina increased coastal runoff rates which deleteriously affected shrimp production. Upper Chesapeake Bay salinities have decreased historically because of an increased rate of runoff due to the reduced amount of forested land in the watershed, but increased water diversion may reverse this trend. Changes in land use have influenced river flow in many areas.

Published results regarding water developments in rivers entering the Azov, Caspian, Black and Mediterranean seas in Europe and Asia all point to the conclusion that no more than 25 to 30 percent of the historical river flow can be diverted without disastrous ecological consequences to the receiving estuary. Comparable studies on six estuaries by the Texas Water Resources Department showed that a 32 percent depletion of natural freshwater inflow to estuaries was the average maximum percentage that could be permitted if subsistence levels of nutrient transport, habitat maintenance, and salinity control were to be maintained. The Second National Water Assessment, prepared by the U.S. Water Resources Council, produced data showing that several U.S. estuaries already have incurred depletion levels greater than those threshold levels. Several models were described or are under development for predicting the ecological effects of freshwater inflow in Texas, Chesapeake Bay and San Francisco Bay.

The importance of the salinity transition zone in estuaries for mineralization, mobilization, and release of nutrients from the substrate of estuaries was described. Remote sensing can be used to monitor salinity, chlorophyll a, temperature and suspended sediment in estuaries.

Studies on Potomac River water quality from 1920 to 1979 identified the importance of suspended sediment in preventing algae blooms where nitrogen and phosphorous levels in inflowing water have increased. Research in wetlands adjacent to a heavily developed resort area in Florida predicted that freshwater inflow can be partially restored through a combination of retention structures (small lakes) and spreaders to attain sheet flow into the estuary. The capability of predicting delta formation for several Louisiana estuaries exists and should facilitate planning over-dike freshwater inflow introductions.

All sections of the conterminous U.S. coast were covered in the research papers, but there were more papers from the Gulf of Mexico than from other coastal areas.

PLANNING

Planning problems and ideas were generated by many papers and in the discussion. Several speakers emphasized the need for multi-agency and interdisciplinary studies and planning efforts. Clearly defined ecological and development goals must be established for individual estuaries. These goals may describe types of habitats (e.g., intermediate and freshwater marsh in Louisiana) that are needed, desired organisms to be maintained, and uses of estuaries and freshwater supply by people. Management for protection of estuaries mu be comprehensive; it must extend u stream and include water and la use. Although many models use finfi or shellfish production to evalua the effects of freshwater inflo several authors felt that it would l preferable to use community conditi or ecological structure and process to evaluate effects.

Comprehensive management mu involve getting the support of ma local, state, and Federal agencie plus special interest groups. they are properly used there are ma state and Federal mandates and dire tives that can provide justificati for providing freshwater inflow estuaries.

In Louisiana it has been diff cult to get local support for rei troducing freshwater inflow in estuarine habitats because the loc and short-term demands are high, a long-term impacts, while beneficia are foregone. Small-scale fres water-introduction programs are bei tried to demonstrate the values maintaining more natural dispers before large-scale programs are u dertaken.

RECOMMENDATIONS

Specific recommendations we made by speakers and general reco mendations were developed at t closing plenary session with sign ficant audience participation. The is some overlap between the specif and general recommendations, but bo are presented below. Some specif recommendations apply to restrict geographical areas.

Specific Recommendations

1. Baseline data files on individual estuaries should be established for use in identifying future ecological change.

2. Mission-oriented agencies responsible for developing management plans or for land acquisition and zoning in the coastal zone should establish draft priorities for their activities for the estuaries of the United States. These priorities should then be evaluated and tradeoffs developed by interagency groups, regional or state agencies so that the established priorities will serve environmental, commercial, urban, and other interests in a comprehensive manner.

3. Criteria for evaluating the freshwater needs of estuaries must be established on a national level. Criteria may be either purely physical or ecological, but physical criteria are easier to establish on a national level. Salinity must be considered because it is a fundamental ecological factor and is easily measured.

4. Refined methods for evaluating the economic and non-economic benefits of freshwater inflow to estuaries need to be developed. Beneficial uses of estuaries must be defined and justified more clearly if adequate fresh water is to be provided through water rights decisions.

5. Planning for freshwater inflow to estuaries should be based on the carrying capacity approach, but trend analysis may be used to identify change. Carrying capacity is defined as the capability level of the estuary units to produce essential ecosystem products and services.

6. The ecological effects and economic consequences of proposed inland water development projects must be tracked to and through the estuaries. Coastal ecological communities and estuarine values must be included in tradeoff analysis of upriver planning through impact assessment.

7. There needs to be a stronger and more effective use of existing state, regional, and Federal regulations and mandates to bring freshwater inflow into water planning.

8. The reintroduction of freshwater into estuarine ecosystems in the lower Mississippi River region should be primarily a Federal responsibility because most of the diversion of fresh water away from estuarine habitats resulted from Federal flood control and navigation projects.

9. Management and research programs on rivers and watersheds should be integrated with those for estuaries.

10. Information developed abroad showed that a reduction of over 25 to 30 percent of natural river flow resulted in disastrous ecological consequences in estuaries. Therefore, we suggest that (1) the U.S. Environmental Protection Agency give serious consideration to promulgating a standard for cessation of further consumptive depletion of natural freshwater inflow until it can be shown that additional depletion can be tolerated, and (2) that the U.S. Water Resources Council include as part of the President's proposed Independent Project Review Process a criterion for evaluating adherence to such a standard.

General Recommendations

At the final plenary sessio four general recommendations wer presented and discussed. It was stated that although the importance of the estuaries has been recognized by Congress since the early 1960's and was stated explicitly in the passage of the Estuary Protection Act in 1968, few recommendations of professional groups have been acted on effectively to protect estuaries. One problem is that estuaries are so variable the scientists, engineers, and planners have not worked together effectively on a national level to reach a general consensus on how estuaries can be managed and protected. There has been some success at regional and state levels. An action program to protect estuaries is needed because of the extremely high productivity of estuaries and because they are vital to coastal and ocean ecosystems and to the Nation as a whole. Although such mandates as the Coastal Zone Management Act, National Environmental Policy Act, Clean Air Act and the Estuary Protection Act strive to protect estuaries, there is a lack of a clear mandate to protect them systematically and effectively. Accordingly, four general recommendations were developed at the symposium:

1. Estuaries are complex ecosystems that can be managed for common purposes. Some types of water use in estuaries will serve special purposes, but compromises can be worked out. Man-caused changes in freshwater inflow or other morphological or hydrological changes in estuaries must be evaluated as to how the changes will affect the structure and processes in estuarine ecosystems.

2. There should be a nationwide mandate to recognize estuaries as resources of extremely high value and worthy of protection.

3. Each estuary must be treated as a unit resource and must have its own management plan. We need, however, a conservation objective that can be applied to estuaries in general and that can be visualized by the political sector, the public, fishermen, engineers, planners, and scientists. We propose that optimal salinity regimes should be established as conservation objectives for each estuary with optional sediment and hydrological regimes as related objectives. These regimes shall recognize seasonal, annual, and historical variation. If these objectives are properly established and implemented, they will protect estuary ecosystem functions and processes. These conservation objectives shall serve as targets for planning and management in estuaries.

4. Finally, we should pursue these recommendations with governmental agencies, Congress, and elsewhere to bring the protection of estuaries as a national issue to be considered in all water development and management programs.

CONCLUSIONS

The symposium brought together people from a variety of disciplines and special interests to deal with the problem of tying together inland river management and land use planning for the protection of estuaries. It reviewed the progress that is being made to bring freshwater inflow to estuaries into water planning. It identified weaknesses in our data base that must be filled before detailed estuarine protection programs can be developed. It identified existing Federal and state legal and regulatory mandates that can be used to bring freshwater inflow into planning.

The diversity in estuarine ecosystems has prevented an effective nationwide program to establish criteria and objectives for estuarine protection. Also, the responsibility for environmental management and planning in estuaries is dispersed among many Federal and state agencies and local governmental units. Coastal zone management programs have not been generally effective in protecting estuaries.

The recommendations emphasized the need for a nationwide approach to develop criteria for the balanced uses of estuaries which would serve to preserve and enhance their environmental values. The responsibility for protecting estuarine ecosystems needs to be defined more clearly at the Federal level so that all upstream projects affecting water supply must be evaluated relative to their effects on estuaries. Finally, efforts must be made to protect estuarine ecosystems as a nationwide policy.

Sunrise, Mt. McKinley Ansel Adams

SIERRA CLUB LEGAL DEFENSE FUND, INC.

The Law Firm for the Environmental Movement

180 Montgomery Street, Suite 1400 San Francisco, CA 94104-4209 (415) 627-6700 FAX (415) 627-6740

10.106.01
September 26, 1994

Tom Hagler
Office of Regional Counsel
EPA Region IX
75 Hawthorne Street
San Francisco, CA 94105

Dear Tom:

Enclosed please find a disk with our March 11, 1994 comments on EPA's proposed water quality standards for the San Francisco Bay-Delta, saved in three different formats:

(1) SCLDF.CMT: This is our original WordPerfect 5.1 file, formatted for a Hewlett Packard LaserJet IIID printer.

(2) SCLDF.ASC: This is ASCII text, or plain DOS text.

(3) SCLDF.GEN: This is a "generic" WordPerfect file. If you use WordPerfect or something that can read WordPerfect files, then using this generic file should save you from the garbles of switching from one printer format to another within WordPerfect.

I hope one of these formats will be easily useful to you. Please let me know if I can help further.

Sincerely

D. Perry de Valpine

Perry de Valpine
Research Assistant

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

SEP 2 8 1994

James H. Lecky
Director, Protected Species Management Division
501 W. Ocean Blvd., Suite 4200
Long Beach, California 90802

Request for Technical Assistance on Spring-run Chinook Salmon

Dear Mr. Lecky:

As you know, the Environmental Protection Agency (EPA), the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) are presently engaged in formal consultations under section 7(a)(2) of the Endangered Species Act (ESA) on the potential impact of the EPA's water quality standards promulgation on threatened and endangered species in the San Francisco Bay/Delta. NMFS primary concern in those consultations are potential adverse impacts on the listed endangered winter-run chinook salmon.

We understand that NMFS, in its Federal Register notice dated September 12, 1994 (59 FR 46808), initiated a status review on a number of Pacific salmon and anadromous trout, including the spring-run chinook salmon found in the Bay/Delta and Sacramento/San Joaquin River watershed. This status review, which is not scheduled to be completed until December 15, 1995, will determine whether NMFS will propose the spring-run for listing under the ESA.

The spring-run chinook salmon is presently neither a listed species nor a formally proposed species under the ESA. For that reason, EPA does not have any obligations under section 7(a)(2) to request a consultation or conference on how EPA's actions may affect the spring-run. Nevertheless, given the attempt of the Federal agencies to identify potential problems in the estuary, we are asking NMFS to provide us with its present thoughts on the measures necessary to protect the spring-run chinook salmon. We are especially interested in any measures that would have impacts on the water supply uses of the estuary or on the implementation of EPA's water quality standards. In addition, we would be interested in your thoughts on the recommendations for the spring-run recently submitted by Natural Heritage Institute and others to the

California State Water Resources Control Board.

We explicitly recognize that your findings at this time are necessarily preliminary, and that further investigation during your status review may lead to additional protective measures. Our intent at this time is to assure that our actions and related actions by regulatory agencies in the Bay/Delta are consistent with what we presently know about the spring-run chinook salmon.

If you have any questions about our request, please contact Patrick Wright, Chief, Bay/Delta Section, (415) 744-1993, as soon as possible.

Sincerely,

Harry Seraydarian

Harry Seraydarian
Director
Water Management Division

cc: Cay Goude, USFWS

File

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

SEP 2 8 1994

Matthew D. Vandenberg
Ecological Services
Sacramento Field Office
U.S. Fish and Wildlife Service
2800 Cottage Way
Sacramento, California 95825

ESA Consultations on Final Water Quality Standards

Dear Matt:

As we discussed on the telephone, I am enclosing a revised statement of the Fish Spawning criteria to be included in EPA's final promulgation of water quality standards in the Bay/Delta.

The only revision we are making to the Fish Spawning criteria is to eliminate references to water year categories. Instead, we are simply dividing the compliance requirements into two categories: those years with a San Joaquin Valley Index either above or below 2.5 MAF. This index level corresponds to the dividing line between dry and below normal years.

If you have any further questions about this, please call me at (415) 744-1375.

Very truly yours,

Thomas M. Hagler
Assistant Regional
Counsel

(b) *Revised Criteria*. The following criteria are applicable to state waters specified in Table 1-1, at Section (C)(3) ("Striped Bass - Salinity : 3. Prisoners Point - Spawning) of the Water Quality Control Plan for Salinity for the San Francisco Bay - Sacramento/San Joaquin Delta Estuary, adopted by the California State Water Resources Control Board in State Board Resolution No. 91-34 on May 1, 1991:

LOCATION	SAMPLING SITE Nos (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	SAN JOAQUIN VALLEY INDEX	DATES	VALUES
San Joaquin River at Jersey Point, San Andreas Landing, Prisoners Point, Buckley Cove, Rough and Ready Island, Brandt Bridge, Mossdale, and Vernalis	D15/RSAN018, C4/RSAN032, D29/RSAN038, P8/RSAN056, -/RSAN062, C6/RSAN073, C7/RSAN087, C10/RSAN112	Electrical Conductivity (EC)	14-day running average of mean daily for the period not more than value shown, in mmhos	Not Applicable	>2.5 MAF	April 1 to May 31	0.44
San Joaquin River at Jersey Point, San Andreas Landing and Prisoners Point	D15/RSAN018, C4/RSAN032, D29/RSAN038	Electrical Conductivity (EC)	14-day running average of mean daily for the period not more than value shown, in mmhos	Not Applicable	≤ 2.5 MAF	April 1 to May 31	0.44

(c) *Definitions*. Terms used in subsections (a) and (b), above, shall be defined as follows:

(1) *Water year.*

A water year is the twelve calendar months beginning October 1.

(2) *8-River Index.* The 8-River Index shall be computed as the sum of flows at the following stations:

1. Sacramento River at Band Bridge, near Red Bluff
2. Feather River, total inflow to Oroville Reservoir
3. Yuba River at Smartville
4. American River, total inflow to Folsom Reservoir
5. Stanislaus River, total inflow to New Melones Reservoir
6. Tuolumne River, total inflow to Don Pedro Reservoir
7. Merced River, total inflow to Exchequer Reservoir
8. San Joaquin River, total inflow to Millerton Lake.

The flow determinations are made and are published by the California Department of Water Resources in Bulletin 120.

(3) *San Joaquin Valley Index.*

(A) The San Joaquin Valley Index is computed according to the following formula:

I_{SJ} = 0.6X + 0.2Y and 0.2Z

where I_{SJ} = San Joaquin Valley Index
X = Current year's April-July San Joaquin Valley unimpaired runoff
Y = Current year's October-March San Joaquin Valley unimpaired runoff
Z = Previous year's index in MAF, not to exceed 0.9

MAF

(B) <u>Measuring San Joaquin Valley unimpaired runoff</u>. San Joaquin Valley unimpaired runoff for the current water year (from the preceding year's October 1 to September 30 of the current calendar year) is a forecast of the sum of the following locations: Stanislaus River, total flow to New Melones Reservoir; Tuolumne River, total inflow to Don Pedro Reservoir; Merced River, total flow to Exchequer Reservoir; San Joaquin River, total inflow to Millerton Lake. Preliminary determinations of year classification shall be made in February, March and April with final determination in May. These preliminary determinations shall be based on hydrologic conditions to date plus forecasts of future runoff assuming normal precipitation for the remainder of the water year.